Urban Soil Characteristics and Their Effects on Greenhouse Gas Emissions

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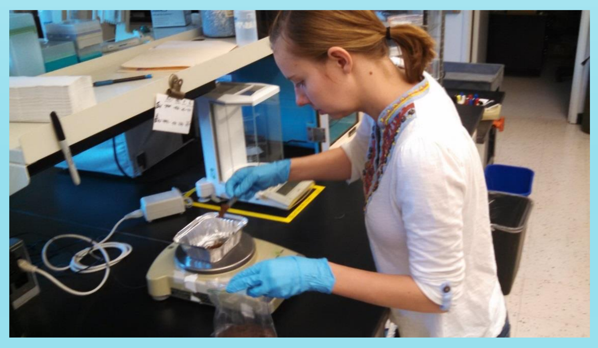
INTRODUCTION

- Agricultural practices and urban land uses may contribute significantly to greenhouse gas (GHG) emissions
- CAP LTER studies have quantified GHG emissions from some terrestrial environments and denitrification rates (resulting in N_2O and N_2) from episodically flooded areas
- Few studies have investigated the soil characteristics in a broad range of urban patch types and how they might relate to GHG emissions

METHODS

- Examined 10 different urban patch types (three replicate sites per patch type; n=30) representing different land uses (see Fig. 1). Three locations within each site were sampled
- Year-long study capturing cool and warm-season soil characteristics (Jun and Nov 2013)
- Collected air samples from three gas chambers placed on the soil surface at each patch replicate; samples were analyzed for N_2O and CO_2 using a gas chromatograph (GC)
- Collected two soil cores and measured soil and air temperature for each gas chamber
- Measured soil moisture, percent organic matter, and extractable inorganic nitrogen in soil cores

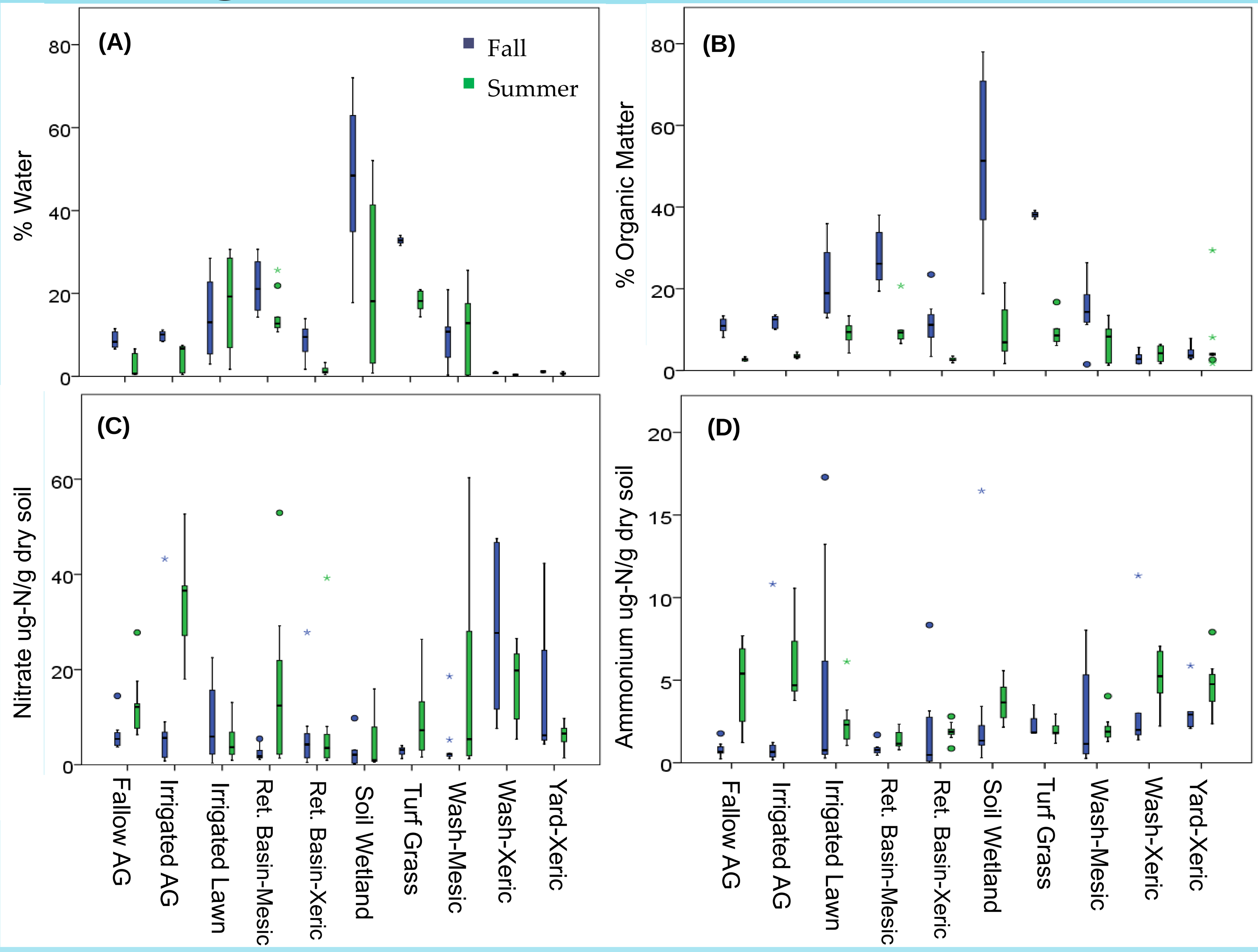


QUESTIONS

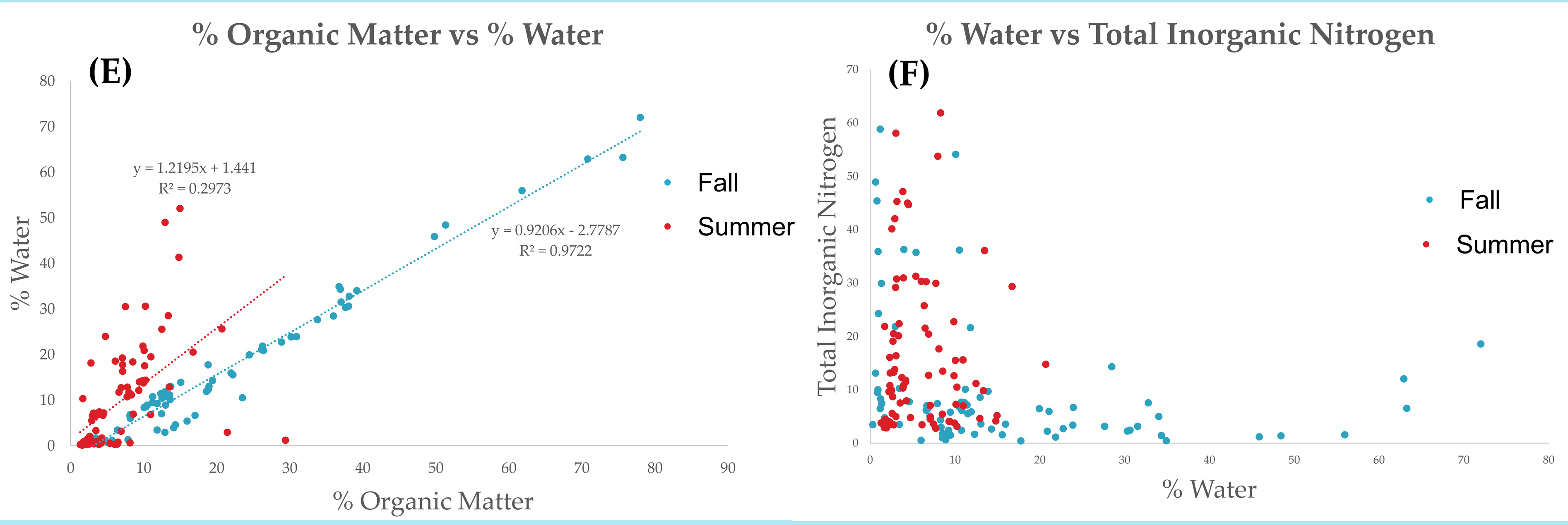
Q1: What are the different soil characteristics for each patch type in the urban Phoenix area?

Q2: What quantity of GHG emissions is predicted from different patch types in the urban Phoenix area?

Figure 1. SOIL CHARACTERISTICS



- Figure 1 boxplots A, B, C, and D show soil characteristics measured from 10 different patch types (n=30) across the urban Phoenix area. Dots = outliers, asterisks = far outliers
- Similar trends for soil moisture and organic matter, high nitrate values for sites with low soil moisture and organic matter



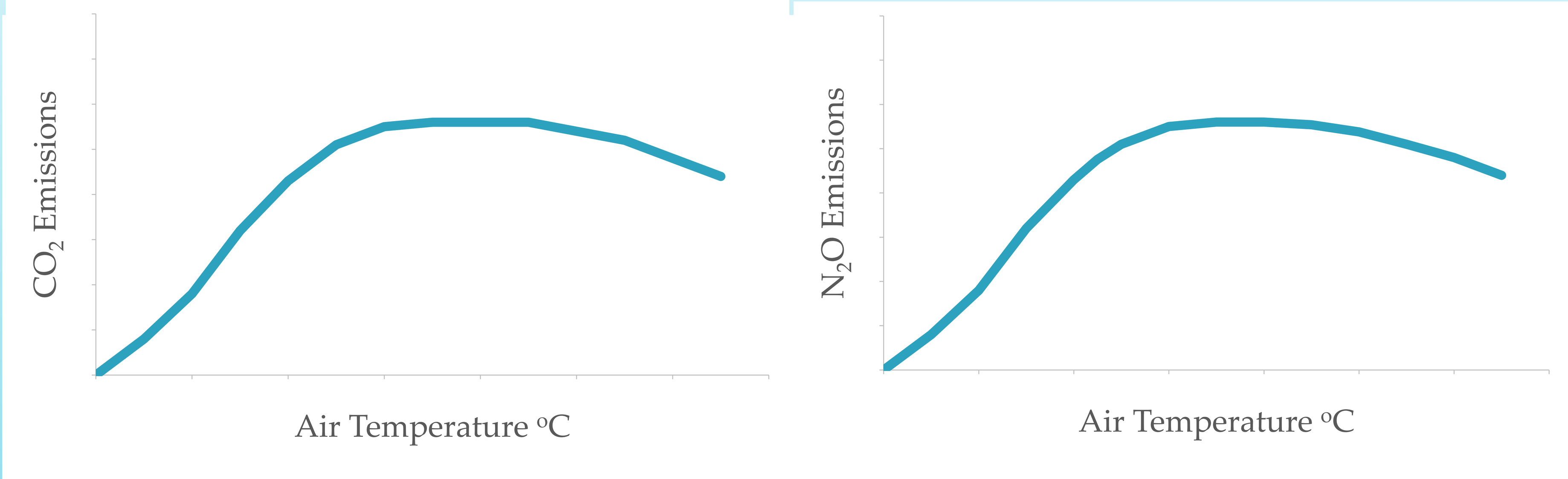
- Figure 1 graphs E and F show relationships between gravimetric soil water content and soil nitrogen (right) and organic matter (left) Organic matter was lower on average during the summer, and demonstrated a strong positive linear relationship with soil moisture. Soil moisture showed a weak quadratic relationship with total inorganic nitrogen

GHG EMISSIONS: PREDICTIONS

N_2O and CO_2 were measured using a gas chromatograph with a dysfunctional detector. CO_2 will be re-measured at all sites using an infrared gas analyzer (IRGA).

1. Air Temperature:

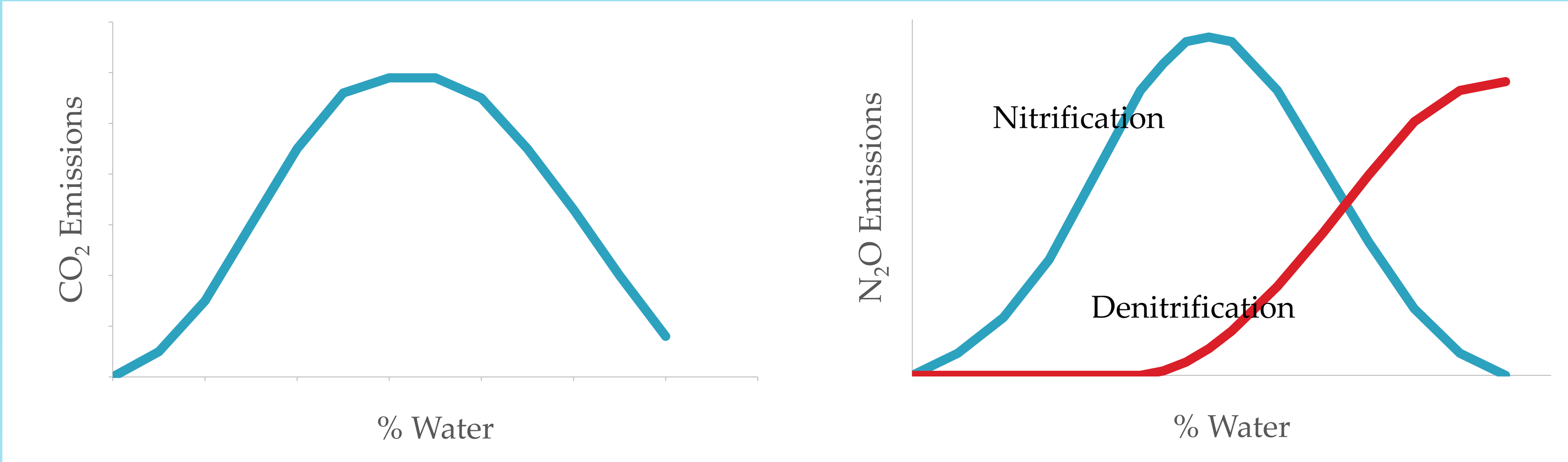
Temperatures stimulates microbial processes, increasing GHG emissions. Very high heat will stress or kill microbes and decrease emissions slightly



2. Soil Moisture:

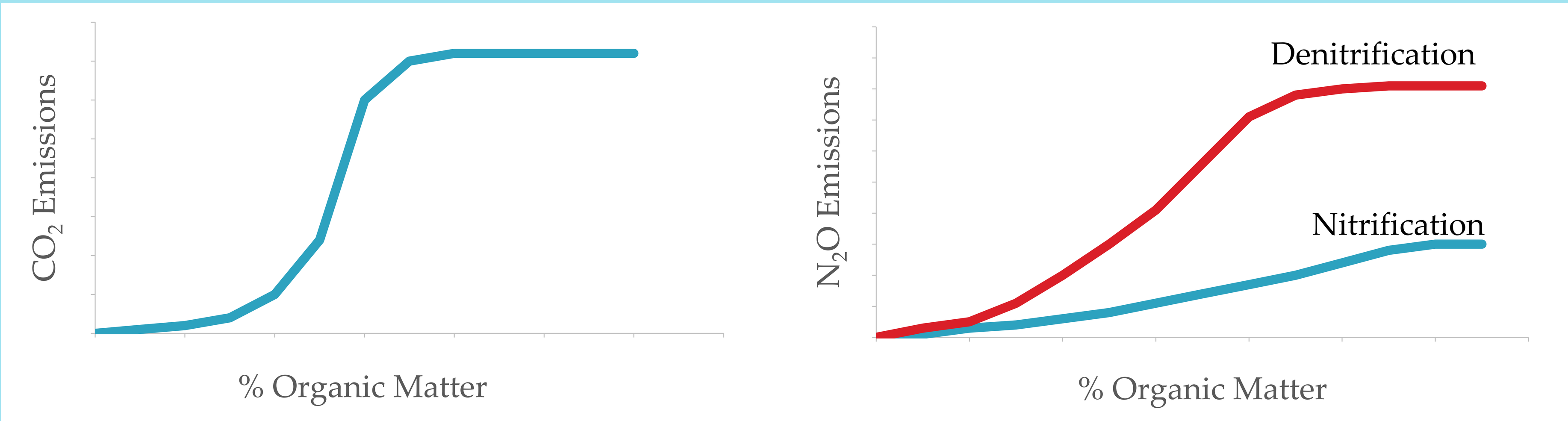
GHG production will be low when soil moisture is low. If soil moisture is high enough to create anoxic conditions, then GHG emissions will decline

- 2A: CO_2 emissions will decline sharply at high soil moistures
- 2B: N_2O emissions will decline more slowly at high soil moistures, with N_2O production resulting predominantly from denitrification vs. nitrification



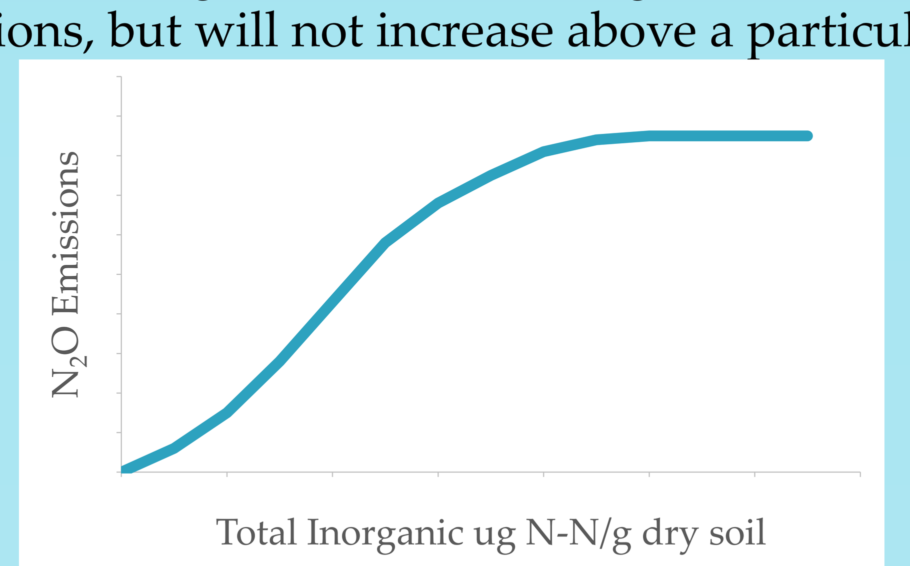
3. Organic Matter:

GHG production will be higher in soils with higher organic matter content, but will not increase above a particular soil organic matter content



4. Inorganic Nitrogen:

Production of N_2O will be higher in soils with higher total available inorganic nitrogen concentrations, but will not increase above a particular inorganic nitrogen content



CONCLUSIONS and FUTURE DIRECTIONS

- This study provides a thorough look at soil characteristics in many different patch types across the urban Phoenix area
- Areas with turf grass (irrigated lawn, mesic basins and washes) and wetland areas had the highest soil moisture and organic matter, potentially indicating high potential for GHG emissions
- Inorganic N is clustered around low %water, potentially from decreased microbial activity related with low %water. This could indicate a decrease in GHG emissions at sites with low soil moisture.
- Large seasonal differences in metrics related to GHG emissions may indicate seasonal shifts in total emissions and GHG hot spot locations
- Gas sample analysis will allow us to use soil variables to estimate the emissions from different land use types

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